DRAFT
Summary of Historical Florida Department of Health Radiological Survey Data for Polk County

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Contents

Notation

The following is a list of the acronyms and abbreviations (including units of measure) used in this report. Notation used only in tables is defined in the respective tables.

Acronyms and Abbreviations

CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
EPA	U.S. Environmental Protection Agency
FDOH	Florida Department of Health
GAO	General Accounting Office
NaI	sodium iodide
NPL	National Priorities List
PIC	pressurized ion chamber
Ra	radium
Rn	radon
U	uranium

Units of Measure

μR/hr	microroentgen(s) per hour (a unit of radiation exposure rate)
pCi/L	picocurie(s) per liter (a unit of airborne radioactivity concentration)
pCi/m^2*s	picocurie(s) per square meter-second (a unit of surface soil radioactivity flux or fluence)
aCi/cm^2*s	attacurie(s) per square centimeter-second (a unit of surface soil radioactivity flux or fluence; divide by 100 to get equivalent units in pCi/m^2*s)
WL	Working Level (a unit of radon progeny concentration)

1. Introduction and Background

Portions of central Florida have areas of marine phosphorite deposits that contain elevated concentrations of naturally occurring radionuclides, including uranium (U) and its decay products. These deposits have been mined for many years for phosphate, and the mining activities have resulted in redistribution and concentration of the radioactive isotopes that are present in the ore material. In particular, the clay slurry and sand tailings that are left after removal of the phosphate from the ore contain concentrations of radium-226 (Ra-226) and its decay products that can be significantly elevated above natural background conditions. Radium-226 is of concern because at elevated soil concentrations it can cause exposure to gamma radiation and radon (Rn-222) gas.

In November 1998, the General Accounting Office (GAO) completed a review of the U. S. Environmental Protection Agency's (EPA's) backlog of sites in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). As a result of this review, it was determined that 21 phosphate mining sites in Florida could be candidates for the National Priorities List (NPL), based on a preliminary analysis, due to risks associated with radioactivity at these sites. Subsequent discussions with the State of Florida identified numerous other mines not yet included in CERCLIS. While reviewing these sites, EPA discovered that in addition to the phosphate mining sites that need to be addressed, several residential areas also merit attention because they were developed on former phosphate mine property.

Because of concerns associated with potential human exposures to radioactive isotopes as a result of residential development of these former phosphate mine areas, an aerial radiological survey has been proposed by EPA. This survey would be a first step in providing additional information on the levels and extent of radioactivity in residential areas, to determine if additional investigations or protective actions are necessary.

During the process of planning the aerial radiological survey, numerous published reports documenting previous radiological surveys of phosphate areas were reviewed by EPA. In addition to published reports, the Florida Department of Health (FDOH) provided access to historical files containing radiological surveys conducted in Polk County from the early 1970s to the late 1990s. These surveys were usually conducted at the request of a homeowner or developer, often because the individual had learned that the home was built in a phosphate-mined area, which may contain radioactivity.

An initial review of the historical files was conducted by EPA during a visit to the FDOH offices in Polk County, Florida, in late April 2004. A more detailed review of data in the files was conducted in May and June of 2004. This report summarizes the review and assessment process for the historical radiological survey files, including a summary of the conclusions reached as a result of the review.

2. Historical Data Review and Assessment Approach

The FDOH historical radiological survey data consists of 53 separate files that were contained within a "bankers box" that had been stored for several years in the Polk County Health Department Environmental Laboratory offices in Winter Haven, Florida.

The survey reports and data were generally filed by development or subdivision name. It appears that, over the years, the approach to filing the surveys had varied, with some files containing information on a single property or on properties within one development, while other files contained multiple surveys covering properties from many areas. As a result, approximately 170 individual properties were identified with specific radiological survey data; each property was treated as a separate entry on the summary tables in this report.

It is evident that a considerable amount of work went into responding to requests for surveys during this period, and that the FDOH was very responsive to requests for surveys. It appeared that, for a period of time during the 1980s, a radiological survey was required by local building codes in the Lakeland, Florida, area prior to starting construction on new residential developments. As would be expected with this type of historical data, documentation varied considerably. Some files included a formal letter report to the individual property owner or developer, while other files contained only handwritten survey measurements on a map or a sketch of the property. The sizes of the properties also varied considerably, from a single residence with less than one acre of land to properties that consisted of more than 700 acres of citrus groves. Because of the size differential, the number of measurements also varied considerably. Often less than twenty measurements were taken with single residences, while some larger properties had up to approximately 300 individual measurements.

The typical historical property survey consisted of multiple outdoor gamma exposure rate measurements, which were reported in μR/hr. In many cases, this was the only type of measurement taken. Gamma exposure rate measurements were typically taken using a gamma scintillation detector (e.g., a Ludlum Model 12S NaI detector), calibrated using a pressurized ionization chamber (PIC). However, for some surveys it was not possible to determine if the results were reported directly from the scintillation detector readings or if they were corrected using a PIC calibration. If a structure was present on the property, indoor gamma exposure rate measurements would also usually be taken.

Some surveys also included radon (Rn-222) measurements using various methods. Radon soil flux measurements were sometimes included for vacant lots, and, if a structure was present, indoor radon concentrations or radon progeny concentrations were measured in a few cases. There were also a few soil samples taken, with results reported for Ra-226 concentration, but these were rare.

In order to summarize the historical data in a way that would be easily understood and useful, separate tables were developed to show results for gamma exposure rates, radon survey results, and Ra-226 soil concentrations. The largest and most useful of these tables by far is the gamma exposure rate summary table (Table 1). This table was used to develop a map (Figure 1) that summarizes the locations of the historical data. An oversized map (Attachment 1) showing a detailed summary of historical survey results was also developed.

The tool used to summarize the potential impact or meaning of the historical results for each property was a simple yes/no (Y/N) flag to indicate whether the historical results showed evidence of the presence of radiation in sufficient quantity to warrant additional

investigation (based on current radiation exposure guidelines). If the gamma exposure results showed any measurement (indoor or outdoor) greater than or equal to 20 μR/hr, then that property was flagged with a Y, indicating that further investigations or surveys may be warranted. There were a few cases where no maximum exposure rate was reported, or where the reported maximum gamma exposure rate measurement was just under 20 μR/hr but the average reading exceeded twice the background level. These cases were also flagged with Ys, since there was reasonable evidence that radioactive material was present at levels well above background.

The guideline of 20 μR/hr was used as a simple tool in performing a first-level screening of this data to get a sense of whether additional surveys or other types of investigations may be warranted. This screening guideline was not based on a site-specific risk assessment, and a flag of Y should not be interpreted as indicating that there is an unacceptable risk associated with a particular property. This guideline was selected because it is used as an indoor exposure limit (20 μR/hr above background) as part of the EPA's *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings* (40 CFR 192), and because the Florida Administrative Code specifies that the mean gamma exposure rate in a building shall not exceed 20 μR/hr (including background) (Chapter 64E-5.1001). While these regulations apply specifically to indoor exposure rates, the guideline was also applied to outdoor exposure rates as part of this conservative screening evaluation.

While the majority of the Y/N flags were assigned based on gamma exposure rates, other threshold values were considered for radon (Rn-222) and Ra-226 soil concentration measurements when these results were reported. These threshold guidelines included 0.02 Working Level (WL) for radon progeny and 4 pCi/L for indoor radon concentrations. The 0.02 WL guideline is based on the radon progeny criterion specified in 40 CFR 192, and the 4 pCi/L indoor radon concentration guideline is taken from EPA recommendations for homeowners. For Ra-226 soil concentrations, 5 pCi/g was used as an indicator of the need for additional investigation. This concentration is included as a cleanup criterion for surface soil as part of 40 CFR 192, and has also been used for many Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup actions around the country.

3. Summary of Results

A summary of the historical gamma exposure rate survey results is provided in Table 1. For each property surveyed, this table shows the range of exposure rates (minimum and maximum) as well as the average, where available. Because most of the surveys were conducted on undeveloped lots, the measurements are generally of outdoor gamma exposure rates, but several surveys were also conducted inside of homes; these results are included in Table 1 as indoor measurements. Table 2 provides a summary of radon measurement results, and Table 3 provides Ra-226 soil concentration data for those properties where these types of measurements were conducted. Figure 1 provides an overall summary of the locations of the historical survey data. Attachment 1 provides a more detailed summary of historical survey results and whether additional investigations may be warranted for each survey location. The entire set of historical survey files used

to develop this summary is provided in a compact disc that has been attached (Attachment 2) to this report.

In general, the gamma exposure rate survey results across all of the historical files show significant variability, with exposure rates ranging from background (approximately 6 μR/hr) to approximately 100 μR/hr. Those areas where the survey sheets reported phosphate mine wastes (clay slimes and sand tailings) typically showed numerous measurements greater than 20 μR/hr (generally 20 to 40 μR/hr). Approximately 40% of the properties in the historical files were designated with a Y flag (indicating that further investigations may be warranted) based on gamma exposure rates. With the exception of four locations, the properties with Y designations are included in the current area designated for coverage as part of the planned aerial radiological survey.

While there were fewer radon measurements than gamma exposure rate measurements, the locations with high radon levels generally also tended to have elevated gamma exposure rates. This was not always the case, and as rule gamma exposure rate measurements do not reliably predict elevated radon levels. There were also a limited number of Ra-226 soil sample results with concentrations ranging from 1.7 pCi/g to 37 pCi/g. For comparison purposes, EPA and other federal agencies have generally used 5 pCi/g above background as a cleanup criterion for soils containing Ra-226. The locations with the highest reported Ra-226 concentrations generally corresponded to those with gamma exposure rates significantly greater than background.

It should be noted that while the historical data files provide useful information about the areas covered in these surveys (approximately 170 areas), these files do not represent comprehensive radiological survey coverage of all of the historical or current phosphate mine areas in Polk County. In addition, the areas covered by the historical surveys have an uneven distribution of measurement locations due to the measurement protocols used at the time and access problems for some properties. Because there are large areas where phosphate mining activities have taken place that are not included in these surveys, and because of the limited number of measurements taken on each surveyed property, there may be areas where elevated radioactivity was not identified.

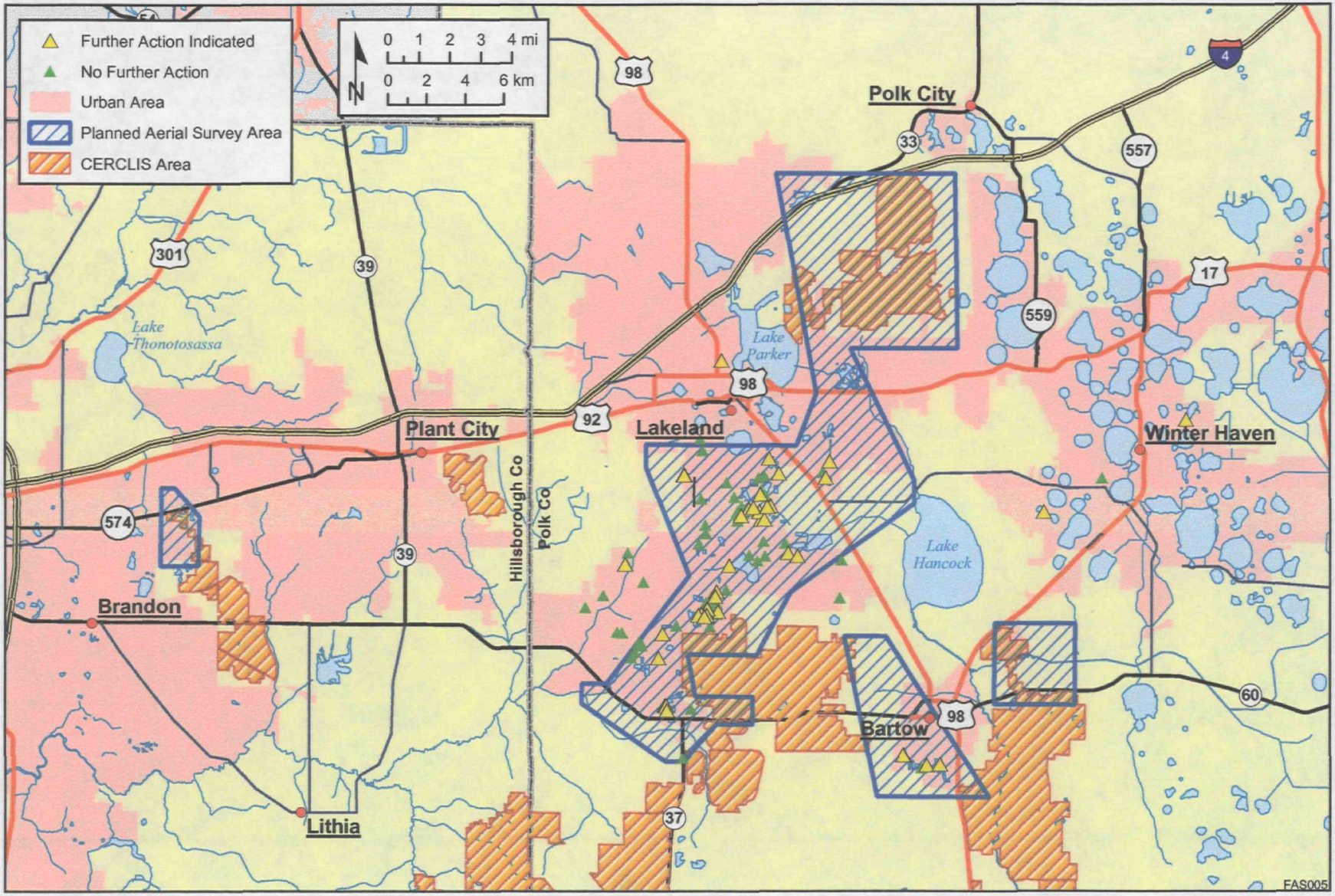
4. Conclusions

In general, the results from the review of FDOH historical survey data show that there are a significant number of properties located over former mine areas that have the potential to contain radioactivity (Ra-226) at levels exceeding current remedial action guidelines. The overall conclusion from this review is that the historical survey results support the concept that additional screening or characterization surveys are warranted for residential developments built over former phosphate mines.

5. References

Code of Federal Regulations, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, 40 CFR 192.

Florida Administrative Code, *Control of Radiation Hazard Regulations, Radon,* Chapter 64E-5.1001, July 1998.


Further Action Indicated
No Further Action
Urban Area
Planned Aerial Survey Area
CERCLIS Area
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Polk City
Plant City
Lakeland
Winter Haven
Brandon
Lithia
Bartow
Lake Thonotosassa
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Lake Hancock
Hillsborough Co
Polk Co
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33
557
4
301
39
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TABLE 1

Table 1. Summary of Historical Florida Department of Health Radiological Survey Results for Selected Subdivisions and Property Developments –Gamma Exposure Rate Data

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
1. American Cyanamid N. E. Lakeland (1987)	5/18/87, 5/19/87	5	10.5	27	Y	212 measurements in 1987.
	5/6/82	4	8.3	29	Y	333 measurements on 0.1-mile grid in 1982. Used Ludlum 12S calibrated with PIC.
2. Harden Oak subdivision	8/3/77	2	~5	10	N	Map shows results from gamma survey. Text reports "readings were well below accepted limits."
3. Braden River Lakes	5/13/87	4	4.5	5.5	N	Map shows gamma survey results (no survey report) for 41 measurements.
4. Barrett, Haentjens & Company	4/19/76	Indoor 9.5 Outdoor 8.6	Indoor 11 Outdoor 22.9	Indoor 16 Outdoor 40.9	Y	Results reported in letter that included a description of EPA's interim guidelines for phosphate lands (construction restrictions if exposure rate >10 μR/hr). 12 indoor and 14 outdoor measurements. High values near slag heap.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
5. Berry Lake subdivision	4/19/76	10.0	17	33.5	Y	Survey conducted over reclaimed phosphate land being considered for development. PIC used for all 24 measurements. Transmitted in letter describing EPA interim recommendations for limiting construction on phosphate lands. Some areas noted as inaccessible.
6. Brittany Place subdivision	3/6/76	2.8	7.8	19.6	Y	External gamma exposure rate survey conducted over property on March 6, 1976, using a 100- × 100-ft grid. Measurements (135) taken with a NaI detector calibrated with a radium needle (Ra-226). Reference is made to soil samples and Rn flux measurements in a December 7, 1984, letter, but no results are available in the file.
7. Canyon Lakes/Doremous	6/2/83	6	~11	16	N	75 measurements taken of property. Report estimated 19% of homes built would have radon problems.
8. Stone Gate subdivision	No date	NM[c]	NM	NM	NA[d]	Contains no radiological survey data, but does include information on developers and mining history for some developed areas.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
9. Cliff Manor Acres	1/30/78	2 (General area)	See note	4 (General area)	N	Contains one page (cover page for survey) indicating that results of gamma measurements were generally 2-4 μR/hr except for a rock and dirt pile where readings were much higher. A map is referenced for specific measurements, but no map was in the file.
10. Citrus Groves	March 1976	See note ~4	See note See note	70 10	Y Bartow area N Other areas	Several citrus groves, totaling 710 acres, on reclaimed phosphate lands were surveyed in March 1976 with "EPA Ludlum." Gamma measurements generally low (less than 10 μR/hr) with exception of groves in the Bartow area where rates were measured as high as 70 μR/hr. Reference is made to collection of soil samples from six groves with the highest gamma levels, but no sample results are in the file.
11. Christina Woods, Lot 346, Phase 9	2/16/83	37	46	68	Y	26 exposure rate measurements, lowest 37 μR/hr (Ludlum 12S). Letter from FDOH indicates 80% probability of Rn problems.
12. Blue Cove Condominiums (Bartow)	2/7/78	15	31	60	Y	Letter from FDOH also provides Rn flux data and comparisons between measured gamma radiation and Rn flux data and recommended guidelines. Ludlum 12S

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
						used.
13. Country Lakes development	7/14/80	8	18.1	36	Y	287 measurements taken and reported as μR/hr calibrated with a PIC. FDOH letter concludes that the property has about 2 to 3 times the normal background exposure rate, and a significant number of homes built on this property will probably have indoor radiation levels greater than recommended federal guidelines.
14. Crystal Acres	2/25/77	2	No ave. reported	30	Y	No summary report of results. Maps show wide variability in exposure rates, with max of 30 μR/hr. EPA Ludlum instrument used for survey. About 106 measurements taken.
15. Edgewood extension	9/13/79	6	13.6	26	Y	Most results less than 20 μR/hr, ranging from 6 to ~15 μR/hr. Measurements (83) taken with Ludlum 12S calibrated to a PIC.
16. Drummond Coal Co./Country Lakes subdivision	10/9/78					Section A was planned for commercial use, while Section B was planned for residential use. FDOH letter cautions that there are large amounts of higher-activity slimes that if excavated (to form lakes) and redistributed would likely cause radiation levels to rise. Also recommended resurvey of the area after it
Section A:		8	15	35	Y	
Section B:		5	20	40	Y	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
						has been reclaimed and lots staked out. 233 measurements in Section B; number of measurements in Section A not specified. Limited access in Section A.
17. FL Phosphate Institute	2/11/82	26	27	29	Y	Results shown for foundation soil after addition of clay-sand mix. Results from four soil samples showed 5.6, 12.8, 13.1, and 16.6 pCi/g Ra-226. 21 measurements taken with Ludlum 12S.
18. Girls Villa	1/1/78	Indoor 3 Outdoor 5	Indoor 3 Outdoor 7	Indoor 4 Outdoor 8	Y	Rn progeny measurements taken from 7 Girls Villa residences using two methods (TLD and Track Etch). H based on radon measurements. Gamma measurements low (See Table 2 for Rn results).
19. Branco Enterprises – Lakeland property	5/16/79 and 1/25/78 (both reference same survey)	8	12.86	20	Y	50-acre property surveyed on 12/30/77 for gamma exposure rates (168 measurements) with Ludlum scintillation detectors. Rn flux measurements taken in 7 locations. Field notes indicate entire area filled with mining byproduct soil/clay mixture.
20. Lake Canyon	4/20/81 4/22/81 (letters)	NM	NM	NM	Unknown	Two letters in file documenting correspondence related to building requirements to provide radiation protection for the Lake Canyon

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
						development. There is no reference to survey measurements.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
21. Lake Hancock residential community	9/3/82 (receipt stamp)	NM	NM	NM	Unknown but probably Y, based on note in file	This file contains an application for a binding letter of interpretation and other correspondence related to the Lake Hancock development. There is no radiological data in the file. A handwritten note on the application indicates that the area "should be gamma surveyed ASAP – it is probably hot as a pistol," but no data is available.
22. Meadow Lakes development	9/22/80 (letter on entire subdiv.) 11/6/81 (letter on mobile home portion) 10/10/83 (portion of land previously surveyed)	5	13 30 (ave. on portion for mobile homes) 9	48	Y Y N	Meadow Lakes is a large multi-use residential development that includes single-family homes, multi-family town homes and garden apartments, a park, and commercial areas. The maps generally show low exposure rates except for the areas designated for multi-family garden apartments (exposure rate range 15-48 μR/hr) and multi-family townhouses (exposure rate range 21-32 μR/hr) in the NE sector of the development. 214 measurements made. A separate letter report for the mobile home and multi-family garden apartments areas (11/6/81) indicates that the average exposure rate was 30 μR/hr for the mobile home area, and that the other area must use improved

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
						slab designs to limit Rn concentrations.
23-1 Mission Oaks subdivision	5/13/76	15	21.4	35	Y	Survey consisted of 54 gamma measurements taken mostly along public rights of way within the Mission Oaks and Parkview subdivisions.
23-2 Parkview subdivision	5/13/76	12	21.4	38	Y	
24. Morningview subdivision	7/24/86 (letter)		Bkg.[e] (~3-8)		N	Two gamma surveys conducted. In first survey, a couple of areas were identified with exposure rates greater than background (11 μR/hr max). After removal of one foot of soil from these areas, they showed background exposure rates. 37 measurements taken.
	6/24/86 (letter)	3	4.9	11	N	
25. Mustang Village development	4/29/79	23	~25	34	Y	All gamma exposure rates greater than 20 μR/hr, general average approximately 25 μR/hr, with a maximum of 34 μR/hr. 90 measurements made.
26. Oakbridge development	5/27/86	15	15-25 Over general area	50	Y	Gamma exposure rates taken from radiation map prepared by the developer.
27. The Pathways subdivision	12/21/78	10	20	50	Y	Gamma exposure rate measurements performed on 60-acre parcel using a Ludlum 12S calibrated to a PIC in December 1978. Gamma survey performed over smaller area in September
	9/22/77 (initial	General >10	No ave. reported	35		

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
	survey)					1977. Approximately 140 measurements made.
28. Phosphate field maps mined and unmined areas	NA	NM	NM	NM	NA	File contains field maps showing areas of phosphate mines and unmined areas.
29. Raintree Village	10/1/86	3	~5	7	N	Gamma survey showed generally background exposure rates (max. at 7 μR/hr). Ludlum 12S used for 24 measurements.
30. Saddle Creek Village	3/6/80	24	~30	35	Y	Letter reports that all gamma measurements were 24 μR/hr or higher (max. 35), with a strong probability that homes would have radon problems. A Ludlum instrument calibrated to a PIC was used for the 81 measurements.
31. Shady Lake Estates	6/24/77	6	12	24	Y	Survey conducted with Ludlum 12S. Letter from FDOH indicates that land was filled with material from adjacent phosphate pits, and that this material should be removed before placement of structures over it. Approximately 80 measurements made.
32. Ned Sinder property	2/15/84	5	11.3	16	Y	All exposure rate measurements less than 20 μR/hr, but most were approximately 2 times background.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
33. Skyview Estates development						Exposure rate survey of areas A and B conducted due to initial refusal by FHA to provide mortgage insurance (due to radiation concerns). Area A had 6 measurements, and Area B had 10 measurements. Survey results for five other properties in this general area were also shown in this file.
Area A	5/11/76	6	7	10	N	
Area B	5/11/76	6	9	13	N	
Scott Kelly 85 acres	3/19/76	8	~13	19	Y	
Phase II and 117 Shadow Drive	5/17/77	4	~6	8	N	
Phase V	5/17/77	4	7	9	N	
20-acre subdivision (proposed)	7/19/77	5	No ave. reported	8	N	
Carver property	3/16/76	5	~13	24	Y	
34. Victoria Square Phase II	11/9/89	6	See note	30	Y	No summary report provided, but gamma exposure rate map shows four areas with ranges of 6-10 μR/hr, 15-30 μR/hr, 20-30 μR/hr, and 6-10 μR/hr. Surveys conducted with Ludlum μR meter.
35. Village South project	5/14/79	6	9	12	N	Report notes that eight lots proposed for development equal or exceed the interim

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
						EPA guideline of 10 μR/hr for residential dwellings. Spot readings in one home under construction and for the Phase II project were within the 10 μR/hr guideline. Ludlum 12S used for approximately 63 measurements.
36. West Mulberry Heights subdivision	6/23/77	14	31.5	60	Y	Ludlum instrument used for 117 measurements. Letter sent to developer by FDOH advising of the EPA interim guidelines for construction (10 μR/hr).
37. Woodlake						Multiple surveys of the development were conducted on different dates using a Ludlum and PIC. Site #7 (9/29/80 letter) appears to be a small portion of the development (7 measurements), while the surveys on 3/18 (26 measurements) and 3/22 (122 measurements) are more comprehensive and representative of the entire development.
Site #7	9/29/80	9	13	15	N	
Woodlake (122 measurements)	3/22/76	3	11	24	Y	
Woodlake (26 measurements)	3/18/76	9.2	13.6	19.5	Y	
38. Imperial Southgate						Note: these are the same properties as shown in file number 33 and reported above.
Carver property	4/5/76	5	~13	24	Y	
Scott Kelly property (85 acres)	3/16/76	8	~13	19	Y	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Scott Kelly property (20 acres)	7/19/77	5	No ave. reported	8	N	
39. Highland tracts	12/19/77	5	17	35	Y	Ludlum instrument used to take 27 measurements. Some access problems were noted.
40. Imperial Lakes	5/19/76	1	No ave. reported	55	Y	Large development planned for 1,400 acres total: 517 acres singles, 304.5 acres multi-units, 470 acres open space, 69 acres commercial, and 39 acres community services. Survey consisted of 234 exposure rate measurements taken with a Ludlum. Survey shows wide variability in exposure rates, with numerous very low readings (2-4 μR/hr), and a large number of elevated readings (30-40 μR/hr).
41. Miscellaneous gamma surveys						File contains numerous individual property surveys not tied to a single development. Each property is discussed separately below.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
41-1 7008 Willow Run loop	11/21/85	Indoor 4	Indoor 4	Indoor 5	N	All 7 measurements taken indoors.
41-2 Lot 10 of the Pinnacle subdivision	1/9/86	3	4	6	N	Ludlum 12S used for 25 measurements.
41-3 3215 Wren Ln. Mulberry, FL	7/3/79	Indoor 5 Outdoor 3	Indoor 5.5 Outdoor 4	Indoor 6 Outdoor 5	N	8 indoor measurements. 7 outdoor measurements.
41-4 4915 E. White Oak Dr. Lakeland, FL	7/31/79	2	~3	3	N	5 measurements.
41-5 76 Woodside Dr. Lakeland, FL (Lot 203, Phase 6, Christina)	4/26/79	23	26	35+	Y	Indication of "35+" taken directly from survey diagram notes. 25 measurements.
41-6 77 Woodside Dr. Lakeland, FL	4/18/85	Indoor 8 Outdoor 12	Indoor 10 Outdoor 12	Indoor 11 Outdoor 13	Y	Measurements (9 indoor and 5 outdoor) from Ludlum #7152 reported, with conversion table to PIC. Max. indoor and outdoor measurements of 11 and 13 μR/hr, respectively, correspond to PIC readings of 10 and 11 μR/hr, respectively.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
41-7 5104 Woodgreen Ln. Lakeland, FL	5/30/79	5	No ave. reported	7	N	Number of measurements and values not reported.
42. Miscellaneous gamma surveys						Second miscellaneous gamma surveys file.
42-1 6209 Sweetwater Dr. Lakeland, FL	6/19/79	Indoor 5 Outdoor 3	No ave. reported No ave. reported	Indoor 6 Outdoor 4	N	6 indoor measurements. 10 outdoor measurements.
42-2 726 Susan Dr. Lakeland, FL	8/22/86	Bkg.	Bkg.	Bkg.	N	Survey notes state that all measurements were at background levels inside and outside of home (no specific measurement results in file).
42-3 958 Sunshine Way Winter Haven, FL	8/3/84		Indoor 5 Outdoor 5	 Outdoor 6	N	No details provided.
42-4 4157 Stonehindge Lakeland, FL	6/18/85	Indoor 7 Outdoor 4	Indoor 10 Outdoor 7.9	Indoor 13 Outdoor 12	N	9 indoor measurements. 14 outdoor measurements.
42-5	12/23/77	8		10	N	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Lot 26, Dorman Acres Lakeland, FL						
42-6 1217 Shepard Rd. Lakeland, FL	2/4/86	7	9	12	N	34 measurements.
42-7 Lot 166 Shadow Ln. Christina Villa Lakeland, FL	4/26/77	5	7	17	N	32 measurements.
42-8 835 Scott Lake Village Lakeland, FL	4/26/96	Indoor 12 Outdoor 15	No ave. reported No ave. reported	Indoor 15 Outdoor 20	Y	
42-9 SR 60 U.S. Steel property Bartow, FL	3/16/81	6	14	24	Y	80 measurements.
42-10 4117 Stonehinge Lakeland FL	2/6/78	Indoor 5 Outdoor 4	No ave. reported No ave. reported	Indoor 7 Outdoor 9	N	9 indoor measurements. 10 outdoor measurements.
42-11	9/16/80	6	12	19	Y	Well also tested as part of survey. Results

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Haag property Bartow, FL						showed 4.1 pCi/L Ra-226.
42-12 Lot 74 Secret Cove subdivision	6/7/79	9	~10	12	N	All measurements taken with a PIC.
42-13 65 Shadow Ln. Lakeland, FL	2/4/86	Indoor 7 Outdoor 10	Indoor ~8 Outdoor ~13	Indoor 13 Outdoor 15	N	4 indoor measurements. 7 outdoor measurements.
42-14 117 Shadow Dr. Christina subdivision Lakeland, FL	5/17/77	Indoor 4 Outdoor 5	Indoor 5 Outdoor 7	Indoor 6 Outdoor 8	N	12 indoor measurements. 6 outdoor measurements.
42-15 117 Shadow Ln. Lakeland, FL	6/18/79	Indoor 7 Outdoor 6	Indoor 7.5 Outdoor 8	Indoor 8 Outdoor 11	N	6 indoor measurements. 14 outdoor measurements.
42-16 1803 Tristram Lakeland, FL	4/25/80	No min. reported	No ave. reported	7	N	No details provided.
43. Miscellaneous gamma						Third miscellaneous gamma survey file.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
surveys						
43-1 The Oaks School Wilson Rd. Bartow, FL	7/18/90	30	54	106	Y	Survey appears to include some contact measurements with wall surfaces (including the 106 μR/hr maximum). However, several measurements of 30 μR/hr or greater were recorded in classrooms. Measurements were made in basement and first and second floors. Measurements are reported as corrected based on calibration to a PIC.
43-2 6412 W. Neuman Circle Lakeland, FL	No date on letter in file	5	~5	6	N	
43-3 288 Northbrook Ln. Lakeland, FL	7/11/79	Indoor 5 Outdoor 5	Indoor ~5 Outdoor 10	Indoor 6 Outdoor 19	N	Most measurements were less than 10 μR/hr, with the exception of three measurements on one side of the house ranging from 18 to 19 μR/hr. 5 indoor and 13 outdoor measurements were taken.
43-5 4175 Old Colony Rd. Lakeland, FL	5/14/84	NM	NM	8	N	Survey sheet notes that no readings greater than 8 μR/hr were found.
43-6 4090 Old Colony Rd.	6/12/79	NM	NM	8	N	Survey sheet notes that no readings greater than 8 μR/hr were found.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Lakeland, FL						
43-7 106 Oak Square South, Christina Lakeland, FL	4/29/77	Indoor 6 Outdoor 5	Indoor 7 Outdoor 7	Indoor 8 Outdoor 9	N	Ludlum 12S used for 11 indoor and 23 outdoor measurements.
43-8 Brown property P. O. Box 5582 Lakeland, FL	4/29/77	NM	<10	NM	N	
43-9 6327 Oak Square E. Lakeland, FL	2/4/86	NM	4	5	N	The survey sheet notes that the average for interior and exterior readings using a Ludlum was 4 μR/hr. No data was attached.
43-10 102 Oak Square S. Lakeland, FL	6/20/79	4	No ave. reported	7	N	Survey sheet notes that all readings, interior and exterior, were from 4 to 7 μR/hr. 8 indoor and 8 outdoor measurements.
44. Miscellaneous gamma surveys						Fourth miscellaneous gamma survey file.
44-1 Kells property 29S 24 E Sections 5 and 32 Lakeland, FL	5/12/77	3	No ave. reported	60	Y	Measurements taken from a car while driving over 700-acre property.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
44-2 1527 Lagoon Rd. Lakeland, FL	6/19/79	Indoor 6 Outdoor 8	Indoor 7 Outdoor 9	Indoor 8 Outdoor 12	N	8 indoor measurements. 11 outdoor measurements.
44-3 2118 Lake Bentley Court Lakeland, FL	4/13/76	Indoor 7 Outdoor 15	Indoor 8 Outdoor 16	Indoor 8 Outdoor 20	Y	
44-4 1234 Lark Ln. Mulberry, FL	8/8/77	3	4	4	N	12 measurements.
44-5 3005 Lakeland Highlands Rd. Lakeland, FL	5/1/79	No min. reported	16	No max. reported	Y	Labeled Y due to lack of information on maximum exposure rate detected and average of approximately three times background. No details provided.
45. Miscellaneous gamma surveys						Fifth miscellaneous gamma survey file.
45-1 3858 Garnet Dr. Lakeland, FL	7/19/85	5	7	12	N	10 measurements with Ludlum 12S corrected to a PIC.
45-2 McFadden property Greenwood St.	5/18/79	Bkg.	Bkg.	Bkg.	N	Survey sheet just states that results were at background levels. No details provided.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Lakeland						
45-3 Lot 352, The Woods (Goldenrod Court) Lakeland, FL	9/21/83	Indoor 10 Outdoor 12	No ave. reported No ave. reported	Indoor 15 Outdoor 15	N	9 Indoor and 26 outdoor measurements.
45-4 3622 Grove Terrace Lakeland, FL	6/8/77	2	~3	4	N	No details provided.
45-5 1421 Glendale St. Lakeland, FL	1/27/78	Indoor 9 Outdoor 10	Indoor 9 Outdoor 11	Indoor 10 Outdoor 18	N	9 indoor and 6 outdoor measurements taken with a Ludlum 12S.
45-6 5463 Glenmore Rd. Lakeland, FL	12/19/83	4	Bkg.	7	N	Survey sheets indicate background levels found indoors and outdoors.
45-7 Lot 387 Christina Woods	8/28/85	NM	NM	NM	Y (See 47-14)	Survey sheet refers to attached information but no results are in this file. See entry 47-14 for information on this property.
45-8 912 Heather Crest Ln., Lakeland, FL	5/9/77	Indoor 6 Outdoor	No ave. reported No ave.	Indoor 8 Outdoor	N	Letter states that all measurements (indoor and outdoor) were less than 9 μR/hr. 11 indoor and 4 outdoor measurements taken with a Ludlum 12S.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
		8	reported	9		
45-9 Saddle Creek property 1410 US Hwy 92 W	8/27/80	No min. reported	7	No max. reported	N	
45-10 O. J. Kushto property 3600 US 92E	8/21/80	5	7.3	16	N	Survey map shows majority of measurements less than 10 μR/hr, with the exception of a localized area with readings ranging from 14 to 16 μR/hr. 114 measurements taken. Access limited because of thick brush.
45-11 Polk Tech proposed site (136 acres)	2/24/78	5	No ave. reported	7	N	136-acre tract. Rn flux tests performed as well as gamma survey. See Table 2 for Rn results.
45-12 Imperial Southgate Villas #210	10/12/74	5		6	N	Survey sheet indicates that gamma exposures were 5-6 μR/hr inside and outside the home.
45-13 Imperial Southgate Villas #75	12/20/77	4		10	N	All measurements (inside and outside the home) were less than or equal to 10μR/hr. 3 indoor and 6 outdoor measurements.
45-14 3116 Iowa Rd. Lakeland, FL	6/30/78 and 7/5/78	6	13	32	Y	Gamma measurements taken during placement and retrieval of Rn flux canisters.
46. Miscellaneous gamma surveys						6th miscellaneous gamma survey file.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
46-1 Lot #2, Shady Lake Estates Lakeland, FL	9/20/78	6	10.6	17	N	30 measurements taken with a Ludlum 12S.
46-2 Shady Lake Estates development Lakeland, FL	6/24/77	6	No ave. reported	20	Y	Survey conducted for entire subdivision. Highest readings correspond to areas noted with "phosphate materials." Four of the ten lots showed exposure rates less than or equal to 10 μR/hr.
46-3 4637 S Devon Ave. Lakeland, FL	4/24/85			6	N	Survey sheet notes that measurements did not exceed 6 μR/hr outside the home.
46-4 Property on East Edgewood Dr. Lakeland, FL	12/8/80	6	10	18	N	165 measurements taken with a Ludlum 12S.
46-5 5709 Antler Trail Lakeland, FL	12/10/85	5	No ave. reported	8	N	11 measurements taken.
46-6 Property SW of Fairlanes Lakeside Bowling Lanes Lakeland, FL	4/15/77	12	18	30	Y	40 measurements taken.
46-7	3/25/81	Indoor	Indoor	Indoor	N	Letter to owner states that no levels above

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
2919 Ellis Ave. Eaton Park, FL		3 Outdoor 5	4.7 Outdoor 5	6 Outdoor 5		normal background (5 to 7 μR/hr) were found. 7 indoor and 2 outdoor measurements were taken.
46-8 118 Elm Square S Christina Woods Lakeland, FL	4/21/77	Indoor 5 Outdoor 3	Indoor 5.6 Outdoor 3.4	Indoor 7 Outdoor 4	N	All measurements (indoor and outdoor) well below 10 μR/hr. 8 indoor and 8 outdoor measurements taken with a Ludlum 12S.
46-9 107 Elm Square S Christina Woods Lakeland, FL	6/18/79	Indoor 6 Outdoor 5	Indoor 7 Outdoor 7.5	Indoor 9 Outdoor 10	N	9 indoor and 15 outdoor measurements taken.
46-10 703 NE 4th Ave. Mulberry, FL	7/12/79	Indoor 5 Outdoor 9	Indoor 6 Outdoor 10	Indoor 7 Outdoor 13	N	5 indoor and 14 outdoor measurements taken.
46-11 #54 Floral Lakes Bartow, FL	4/10/86	8	No ave. reported	10	N	Survey reports that exposure rates ranged from 8-10 μR/hr inside and outside of the mobile home.
46-12 6332 Fern Lane Lakeland, FL	5/18/77	5	No ave. reported	7	N	Survey report indicates that exposure rates ranged from 5 to 7 μR/hr inside and outside of the home. Measurements taken with a Ludlum 12S.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
46-13 5024 Fairfax W Lakeland, FL	12/27/77	4	7	9	N	11 measurements taken.
47. Miscellaneous gamma surveys						7th miscellaneous gamma survey file.
47-1 824 Ariana St. Lakeland, FL	6/19/79	Indoor 6 Outdoor 4	Indoor 7.5 Outdoor 4.8	Indoor 9 Outdoor 6	N	4 indoor and 8 outdoor measurements taken with a Ludlum 12S. Survey sheet indicates that exposure rates ranged from 4 to 9 μR/hr inside and outside of the home.
47-2 1425 Belmont Ave. Mulberry, FL	8/29/79	Indoor 6 Outdoor 8	Indoor 7 Outdoor 11	Indoor 8 Outdoor 12	N	6 indoor and 11 outdoor measurements taken with a Ludlum 12S.
47-3 904 Brookwood Lakeland, FL	11/12/85	No min. reported	No ave. reported	8	N	Survey sheet indicates that exposure rates were less than 8 μR/hr.
47-4 Lot 374, The Woods 5422 South Brook Drive, Lakeland, FL	3/3/83	Indoor 13 Outdoor 17	Indoor 18 Outdoor 18	Indoor 20 Outdoor 19	Y	16 indoor and 9 outdoor measurements taken with a PIC.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
47-5 County landfill site Bonny Mine Rd. Bartow, FL	5/17/85	20	45	60	Y	Five 1-acre plots. Measurements taken with a Ludlum 12S.
47-6 2012 Spirit Lk. Rd. Lakeland, FL	2/27/84	Bkg.	No ave. reported	40	Y	Survey included a check of blocks used for construction that indicated exposure rates ranging from 30 to 40 μR/hr. Measurements taken with a Ludlum 12S.
47-7 105 Bluff Rd. Jack Grimes property Mulberry, FL	8/17/77	Indoor 3 Outdoor 6	No ave. reported No ave. reported	Indoor 6 Outdoor 9	N	6 indoor and 6 outdoor measurements. Survey sheet shows range of 3-9 μR/hr for indoor and outdoor exposure rates.
47-8 7007 Beverly Rd. Lakeland, FL	10/10/77	4	No ave. reported	10	N	Letter indicates that soil samples tested, but no concentration results in file.
47-9 Charles Bailey property Lakeland, FL	4/14/76	2	No ave. reported	8	N	100 acres of pasture. 8 measurements taken.
47-10 5136 Colbert Rd. Lakeland, FL	5/27/86	Indoor 5 Outdoor 5	No ave. reported	Indoor 7 Outdoor 8	N	5 indoor and 4 outdoor measurements.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
47-12 3275 Cross Fox Lakeland, FL	9/20/82	No min. reported No min. reported	Indoor 8.5 Outdoor 7	No max. reported No max. reported	N	10 indoor and 8 outdoor measurements. Survey reports that general average outside reading was ~7 μR/hr, and inside was ~8.5 μR/hr, (possibly due to fill).
47-13 Lakeland Highlands Lakeland, FL	7/27/79	3	3-4	4	Y	Survey indicated indoor and outdoor exposure rates were 3-4 μR/hr. Sample of well water showed 0.36 pCi/L gross alpha.
47-14 Lot 387 Christina Woods Lakeland, FL	9/4/85	9	No ave. reported	20	N	Survey sheet indicates that exposure rates ranged from 14 to 20 μR/hr in the area of the proposed housing structure. 20 measurements taken.
47-15 Citrus World	2/21/84	See note	See note	See note	N (Survey not related to phosphate activities)	Survey requested due to receipt of potentially contaminated metal from FMC Corp. Letter summarizing results indicates that equipment was the focus of the survey. General area gamma exposure rates ranged from 6 to 15 μR/hr, with the exception of the personnel office, where rates ranged from 60 to 80 μR/hr (attributed to block wall composition). The survey letter does not indicate if this is a contact measurement. Measurements taken with Ludlum 12S.
47-16	8/13/76	No min.	Indoor	No max.	N	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
6135 Christina Dr. S. Lakeland, FL		Reported	~9	Reported		
47-17 6134 Christina Dr. S. Lakeland, FL	12/8/77	Indoor 6 Outdoor 14	Indoor 9 Outdoor 18	Indoor 10 Outdoor 22	Y	11 indoor and 7 outdoor measurements.
47-18 2811 Christie Ln. Lakeland, FL	7/8/77	5	~6	7	N	Survey results shown for both indoor and outdoor exposure rate measurements. All readings were less than 10 μR/hr. Measurements taken with a Ludlum 12S.
47-19 141 Christina Blvd. Lakeland, FL	4/12/77	4	No ave. reported	7	N	
47-20 Lot 23 (Stonegate) Cheverly Dr. Lakeland, FL	11/20/85	6	11	19	Y	Exposure rates reported as corrected (calibrated with a PIC).
47-21 Lot 20 Cheverly Dr. Lakeland, FL	5/14/86	6	8	10	N	21 measurements taken.
47-22 Lots 16 and 17 Cheverly Dr.	9/30/81	No min. reported	7	No max. reported	N	Exposure rate range (min., max.) not provided in survey sheets. Reported average based on correction to a PIC.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
Lakeland, FL						
47-23 6338 Cedar Ct. Lakeland, FL	6/18/74	Indoor 5 Outdoor 6	Indoor 6 Outdoor 7.7	Indoor 9 Outdoor 9	N	Survey shows all exposure rate results (indoor and outdoor) less than 10 μR/hr. 9 indoor and 9 outdoor measurements taken.
47-24 3912 Canyon Lake Point Lakeland, FL	8/28/85	6	~7	8	N	Survey of interior of home only. 10 measurements taken.
47-25 311 S Carlton Circle W Lakeland, FL	11/26/85	3	4	5	N	Survey of interior of home only. 6 measurements taken.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
48. Christina area						
48-1 Christina property (Mr. Sluder) (no specific address) Lakeland, FL	2/9/77	9	11	14	N	15 measurements taken on lot.
48-2 Andress property/ Stephens property	8/25/77	8	26	40	Y	Letters were written for two properties (Andress and Stephens), but the results appear to be the same. This may be one property with different descriptive names.
49. Floral Park Bartow – Garboury property 2055 S. Floral Ave., #97 Bartow, FL	11/25/98	Indoor 12 Outdoor 13	Indoor 26 Outdoor 19	Indoor 32 Outdoor 33	Y	File includes fact sheet on radiation. 15 indoor measurements taken with a Ludlum 12S.
50. Brittany Place						
50-1 Lot 22	3/85	14	16	18	Y	
50-2 Lot 23	3/85	13.9	16.6	23.8	Y	
50-3 Lot 24	3/85	12.3	15.3	18	Y	
50-4 Parrish Rd.	10/19/84	9	12.9	23.6	Y	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
50-5 Clower Rd.	9/12/84	13.2	14.7	17.1	Y	Clower Rd. (3 feet above lot level). This appears to be the first survey of lots 22, 23, and 25.
50-6 Clower Rd.	9/12/84	24.2	25	25.7	Y	Clower Rd. (3 feet over excavated surface of lot with exposed fill [no lot number]).
50-7 Clower Rd.	9/25/84	10.9	15.6	23.8	Y	Clower Rd. (combined survey results from lots 22, 23, and 25).
51. Floral Park Davis property 2055 S. Floral Ave., #249 Bartow, FL	7/22/97	Indoor 24 Outdoor 12	Indoor 26 Outdoor 16	Indoor 28 Outdoor 20	Y	8 indoor and 11 outdoor measurements taken.
52. Bluffs of Christina Condominiums (FDOH surveys)	5/11/98	See detailed results for individual properties below				Numerous gamma exposure measurements made in and outside of residences at Christina Bluffs. Radon tests included for four homes, and surface and subsurface soil samples taken from one location. Results summarized from FDOH report. Gamma exposure measurements reported as corrected based on correlation to a PIC.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
52-1 6719 Trail Ridge Dr. Lakeland, FL	5/11/98	Indoor 8 Outdoor 13	Indoor 8.8 Outdoor 15.3	Indoor 11 Outdoor 25	Y	6 indoor and 13 outdoor measurements taken with a Ludlum 12S.
52-2 Clubhouse Bluffs of Christina	5/11/98	Indoor 10 Outdoor 29	Indoor 11 Outdoor 29	Indoor 12 Outdoor 29	Y	Only one outdoor measurement and 2 indoor measurements were taken at the clubhouse.
52-3 6761 Trail Ridge Dr. Lakeland FL	5/11/98	Indoor 7 Outdoor 10	Indoor 8 Outdoor 13.8	Indoor 9 Outdoor 21	Y	6 indoor and 12 outdoor measurements were taken.
52-4 370 Sweetbriar Ln. Lakeland, FL	5/11/98	Indoor 8 Outdoor 16	Indoor 9.5 Outdoor 18	Indoor 11 Outdoor 21	Y	2 indoor and 10 outdoor measurements were taken.
52-5 362 Sandalwood Ct. Lakeland, FL	5/11/98	Indoor 8 Outdoor 12	Indoor 8.7 Outdoor 15.5	Indoor 10 Outdoor 21	Y	6 indoor and 8 outdoor measurements were taken.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
52. Bluffs of Christina Condominiums (consultant surveys)	May 1998	See detailed results for individual properties below. Gamma results appear to be reported directly from a Ludlum NaI system without correction to a PIC.				Radiation Protection Services preliminary survey report included exposure rate measurements in eight homes and the clubhouse, and soil sampling. Exposure rate measurements listed a range for the average and a max. (no min.).
52-6 6719 Trail Ridge Dr. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 10-15 Outdoor 30-40	Indoor 35 Outdoor 60	Y	
52-7 Clubhouse Bluffs of Christina	May 1998	Indoor NM Outdoor NM	Indoor 20-25 Outdoor 30-40	Indoor 25 Outdoor 70	Y	
52-8 6761 Trail Ridge Dr. Lakeland FL	May 1998	Indoor NM Outdoor NM	Indoor 10-15 Outdoor 30-35	Indoor 15 Outdoor 45	Y	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
52-9 370 Sweetbriar Ln. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 20-25 Outdoor 40-50	Indoor 25 Outdoor 70	Y	
52-10 362 Sandalwood Ct. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 15-20 Outdoor 30-40	Indoor 20 Outdoor 70	Y	
52-11 352 Sweetbriar Ln. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 15-20 Outdoor 35-40	Indoor 40 Outdoor 60	Y	
52-12 362 Sweetbriar Ln. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 12-15 Outdoor 40-50	Indoor 20 Outdoor 60	Y	
52-13 6780 Trail Ridge Dr. Lakeland, FL	May 1998	Indoor NM Outdoor NM	Indoor 10-15 Outdoor 30-35	Indoor 20 Outdoor 40	Y	

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
53. Christina Woods	Multiple	See individual property results below				Multiple property surveys as found in the Christina Woods file.
53-1 Lot 395	8/4/85	15	24	30	Y	17 measurements taken.
53-2 Lot 18 Pineberry Court	4/30/85	No min. reported	14	No max. reported	N	Report provides only average exposure rate.
53-3 Sand Pit Graham Fill Dirt Co. Lakeland, FL	4/25/83	15	27	31	Y	10 acres surveyed. Survey report indicates that 17 measurements were taken with a Ludlum 12S.
53-4 Lot 10 Pinnacle Lakeland, FL	1/9/86	No min. reported	4	No max. reported	N	Measurements taken with a Ludlum 12S.
53-5 5595 Pheasant Dr. Lakeland, FL	6/18/79	Indoor 6 Outdoor 3	Indoor ~8 Outdoor 4	Indoor 10 Outdoor 5	N	Report indicates that exposure rates ranged from 3 to 5 μR/hr outside, and 6 to 10 μR/hr inside. 3 indoor and 3 outdoor measurements taken.
53-6 1653 Lagoon Place Lakeland, FL	7/13/97	Indoor 3 Outdoor 6	Indoor 3.4 Outdoor 7	Indoor 4 Outdoor 8	N	Ludlum 12S used to make 6 indoor and 6 outdoor measurements.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
53-7 1027 Pheasant Dr. Lakeland, FL	7/13/97	Indoor 5 Outdoor 2	Indoor 6 Outdoor 6	Indoor 7 Outdoor 9	N	Ludlum 12S used to make 6 indoor and 6 outdoor measurements.
53-8 1211 Rolling Woods Ln. Lakeland, FL	7/21/81	7	8.8	12	N	Ludlum 12S used to take 33 measurements. Only two measurements exceeded 10 μR/hr, and these were well outside of the staked planned building area.
53-9 1310 Rolling Woods Ln. Lakeland, FL	7/9/79	9	10.6	13	N	22 measurements were taken of lot and foundation.
53-10 3029 Pineway Lakeland, FL	1/23/85	8	No ave. reported	9	N	No details provided.
53-11 1315 Rolling Woods Lane Lakeland, FL	7/22/85	8	8.7	9	N	9 measurements taken.
53-12 1330 Rolling Woods Ln. Lakeland, FL	11/15/79	7	13.6	17.5	Y	Survey sheet indicates measurements were taken with a Ludlum instrument calibrated to a PIC at the site. Y based on average at twice background.

Subdivision/Development	Survey Report Date(s)	Gamma Exposure Rate (μR/hr)[a]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
53-13 Lot 48 Royal Crest Lakeland, FL	8/23/85	4	No ave. reported	7	N	Measurements taken with a Ludlum 12S.
53-14 Gilly property Lakeland, FL	6/22/77	3	4	8	N	Property located between Reynolds Rd. and Waterfield Rd. in Lakeland.

[a] Gamma exposure rate measurements are outdoor measurements unless noted. Typically these measurements were taken with a Ludlum NaI detector/rate meter calibrated using a pressurized ion chamber (PIC). However, not all surveys stated that the measurements were based on calibrations with a PIC. min. = minimum measurement; ave. = average measurement; max. = maximum measurement.

[b] Qualitative indicator of need for additional follow-up action (characterization or remediation) using yes (Y) or no (N) qualifiers based on historical gamma survey data showing indoor or outdoor measurements that exceed 20 μR/hr; Ra-226 soil concentration greater than 5 pCi/g; indoor radon (Rn-222) greater than 4 pCi/L or radon progeny greater than 0.02 WL. Ra-226 and Rn concentration data are shown in Table 2 and Table 3, respectively. In some cases a Y was assigned when the maximum reported exposure rate was less than 20 μR/hr. This typically was the case if minimal data was available (e.g., no maximum exposure rate reported), and the average exposure rate was on the order of two times background or more.

[c] NM = No measurement reported.

[d] NA = Not applicable.

[e] Bkg. = Background.

TABLE 2

Table 2. Summary of Historical Florida Department of Health Radiological Survey Results for Selected Subdivisions and Property Developments – Radon Measurement Data

Subdivision/Development	Survey Report Date(s)	Radon Measurement Result [aCi/(cm^2*s), pCi/(m^2*s), WL, or pCi/L, depending on type of measurement[a]]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
12. Blue Cove Condominiums (Bartow)	2/7/78	80 aCi/ (cm^2*s)	339 aCi/ (cm^2*s)	1,300 aCi/ (cm^2*s)	Y	Letter from FDOH provides gamma exposure rate and Rn flux data with comparisons to recommended guidelines. During this period, FDOH referenced an indoor radon guideline recommended by EPA of 50 aCi per cm^2*s. 30 measurements were taken.
17. FL Phosphate Institute	2/11/82	1.84 pCi/ (m^2*s)	5.53 pCi/ (m^2*s)	9.03 pCi/ (m^2*s)	Y	Results shown for foundation soil after addition of clay-sand mix. Y is based on gamma exposure rates (see Table 1). 21 measurements taken.
18. Girls Villa	1/11/78	0.007 WL	0.027 WL	0.065 WL	Y	Rn progeny measurements taken from 7 Girls Villa residences using two methods (TLD and Track Etch). By TLD, 4 of 7 exceeded 0.02 WL. By Track Etch, 6 of 7 exceeded 0.02 WL. TLD results shown in table. Y based on radon measurements – gamma measurements low.

Subdivision/Development	Survey Report Date(s)	Radon Measurement Result [aCi/(cm^2*s), pCi/(m^2*s), WL, or pCi/L, depending on type of measurement [a]]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
19. Branco Enterprises Lakeland property	5/16/79 and 1/25/78	10.34 aCi/ (cm^2*s)	217.56 aCi/ (cm^2*s)	1049.73 aCi/ (cm^2*s)	Y	50-acre property surveyed on 12/30/77 for gamma exposure rates (168 measurements) with Ludlum scintillation detectors. Rn flux measurements taken in 7 locations. Field notes indicate entire area filled with mining byproduct soil/clay mixture.
42. Miscellaneous gamma surveys						Second miscellaneous gamma surveys file.
42-5 Lot 26 Dorman Acres Lakeland, FL	12/23/77	6.25 aCi/ (cm^2*s)	31 aCi/ (cm^2*s)	86 aCi/ (cm^2*s)	N	
43. Miscellaneous Gamma Surveys						Third miscellaneous gamma survey file.
43-1 The Oaks School Wilson Rd. Bartow, FL	7/18/90	NM[c]	NM	NM	Y	Survey data sheets indicate that radon test kits were used, but only gamma exposure rate results are reported in the file (no radon data available).
45. Miscellaneous gamma surveys						Fifth miscellaneous gamma survey file.
45-11 Polk Tech proposed site (136 acres)	2/24/78	15.55 aCi/ (cm^2*s)	123.30 aCi/ (cm^2*s)	536.47 aCi/ (cm^2*s)	N	N based on low gamma exposure rate results (see Table 1).

Subdivision/Development	Survey Report Date(s)	Radon Measurement Result [aCi/(cm^2*s), pCi/(m^2*s), WL, or pCi/L, depending on type of measurement [a]]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
45-14 3116 Iowa Rd. Lakeland, FL	7/7/78 (for radon report)	8.26 aCi/ (cm^2*s)	20.4 aCi/ (cm^2*s)	55.29 aCi/ (cm^2*s)	Y	Y based on gamma exposure rate results (one area at 32 uR/hr) (see Table 1). Radon flux results are low.
46. Miscellaneous Gamma Surveys						
46-1 Lot #2 Shady Lake Estates Lakeland, FL	9/20/78	152.84 aCi/ (cm^2*s)	550 aCi/ (cm^2*s)	1175.71 aCi/ (cm^2*s)	N	N based on generally low gamma exposure rates (see Table 1).
48. Christina Area						
48-2 Andress property/ Stephens property	8/25/77	44 aCi/ (cm^2*s)	558 aCi/ (cm^2*s)	3,170 aCi/ (cm^2*s)	Y	Letters were written for two properties (Andress and Stephens), but the results are the same. This appears to be one property with different descriptive names.
49. Floral Park Bartow – Garboury property 2055 S. Floral Ave., #97 Bartow, FL	11/25/98	4.4 pCi/L	4.6 pCi/L	4.7 pCi/L	Y	Indoor radon measurements conducted using two "E-Perm" radon test kits.

Subdivision/Development	Survey Report Date(s)	Radon Measurement Result [aCi/(cm^2*s), pCi/(m^2*s), WL, or pCi/L, depending on type of measurement [a]]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
50. Brittany Place						
50-1 Lot 22	3/85	See note	See note	See note	Y	Radon flux data was reported for lots 22, 23, and 24, but is not shown here because the results from the handwritten survey sheets do not match the summary report tables. Properties flagged, as Y based on gamma exposure rate results.
50-2 Lot 23	3/85				Y	
50-3 Lot 24	3/85				Y	
51. Floral Park Davis property 2055 S. Floral Ave., #249 Bartow, FL	7/22/97	No min. reported	0.5 pCi/L	No max. reported	Y	Y based on gamma exposure rate measurements (see Table 1).
52. Bluffs of Christina Condominiums (FDOH surveys)	5/11/98	See detailed results for individual properties below				Numerous gamma exposure measurements made in and outside of residences at Christina Bluffs. Radon tests included for four homes, and surface and subsurface soil samples taken from one location. Results summarized from FDOH report.
52-1 6719 Trail Ridge Dr. Lakeland, FL	5/11/98	No min. reported	11.3 pCi/L	No max. reported	Y	

Subdivision/Development	Survey Report Date(s)	Radon Measurement Result [aCi/(cm^2*s), pCi/(m^2*s), WL, or pCi/L, depending on type of measurement [a]]			Additional Investigation or Action Indicated (Y or N)[b]	Comment(s)
		Min.	Ave.	Max.		
52-3 6761 Trail Ridge Dr. Lakeland, FL	5/11/98	No min. reported	10.2 pCi/L	No max. reported	Y	
52-5 362 Sandalwood Ct. Lakeland, FL	5/11/98	No min. reported	13.8 pCi/L	No max. reported	Y	
52-1a 6709 Trail Ridge Dr. Lakeland, FL	5/11/98	No min. reported	28.7 pCi/L	No max. reported	Y	This location was not separately listed in Table 1, but the FDOH report includes a note to reference 6719 Trail Ridge Dr. for gamma results.
53. Christina Woods	Multiple	See individual property results below				Multiple property surveys as found in the Christina Woods file.
53-5 5595 Pheasant Dr. Lakeland, FL	6/18/79	NM	NM	NM	N	Report indicates that a radon test was conducted, but no radon results are in the file.

[a] Some older surveys reported Rn flux in aCi/(cm^2*s), while more recent surveys reported Rn flux in units of pCi/(m^2*s). The latter units are more common today. For comparison, results reported in aCi/(cm^2*s) can be divided by 100 to get the equivalent in units of pCi/(m^2*s). While measured Rn-222 soil flux results are reported in Table 2, because they are highly variable, and there is no consensus guideline (for residential exposures) for such soil flux measurements, they were not used in assigning Y or N flags (see footnote b). Indoor radon (Rn-222) progeny concentration results were reported in units of Working Level (WL) and compared to a guideline of 0.02 WL. Rn-222 concentration results were reported in pCi/L and compared to EPA's guideline of 4 pCi/L for residential structures. min. = minimum measurement; ave. = average measurement; max. = maximum measurement.

[b] Qualitative indicator of need for additional follow-up action (characterization or remediation) using yes (Y) or no (N) qualifiers based on historical gamma survey data showing indoor or outdoor measurements greater than or equal to 20 μR/hr; Ra-226 soil concentration greater than or equal to 5 pCi/g; indoor Rn-222 greater than or equal to 4 pCi/L; or radon progeny greater than or equal to 0.02 WL. Ra-226 and Rn-222 concentration data are shown in Tables 2 and 3,

respectively. In some cases a Y was assigned when the maximum reported gamma exposure rate was less than 20 μR/hr. This typically was the case if minimal data was available (e.g., no maximum exposure rate reported), and the average exposure rate was on the order of two times background or more.

[c] NM = No measurement reported.

TABLE 3

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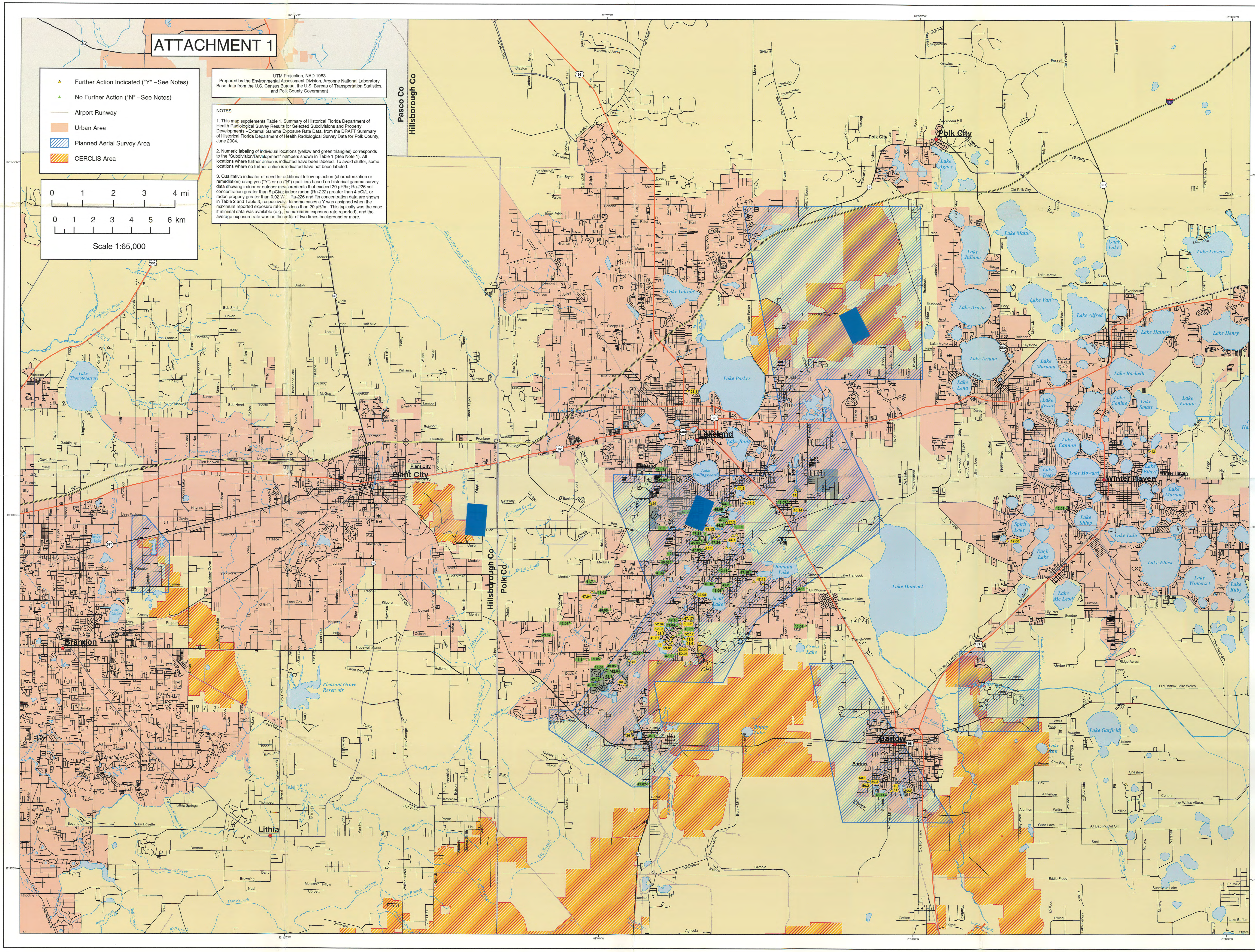
Table 3. Summary of Historical Florida Department of Health Radiological Survey Results for Selected Subdivisions and Property Developments – Ra-226 Soil Concentration Data

Subdivision/Development	Survey Report Date(s)	Ra-226 Soil Concentration (pCi/g)			Additional Invest. or Action Indicated (Y or N)[a]	Comment(s)
		Min.	Ave.	Max.		
17. FL Phosphate Institute	2/11/82	5.6	12	16.6	Y	Results shown for four samples taken from foundation soil after addition of clay-sand mix.
48. Christina Area						
48-2 Andress property/ Stephens property	8/25/77	4.6	20	37	Y	One page in the file includes data for 23 soil samples from what appear to be six locations or cores. Maps show two of the cores (HD3 and HD3B) within the boundary of the property surveyed. The results (8 samples) for these cores are summarized in this table.
50. Brittany Place						
50-1 Lot 22	3/85	3.5	7.5	14.8	Y	Each property had four 6-ft cores located in each corner with a fifth 6-ft core located in the center of each lot. The four corner cores were composited, while the central core had separate analyses of each 1-ft section. The data reported in this table is derived from all samples from the five cores (total of 10 samples) on each lot.
50-2 Lot 23	3/85	4.2	11.1	21.7	Y	
50-3 Lot 24	3/85	1.7	3.6	6.8	Y	

Subdivision/Development	Survey Report Date(s)	Ra-226 Soil Concentration (pCi/g)			Additional Invest. or Action Indicated (Y or N)[a]	Comment(s)
		Min.	Ave.	Max.		
52. Bluffs of Christina Condominiums (FDOH surveys)	5/11/98	See detailed results for individual properties below.				Numerous gamma exposure measurements made in and outside of residences at Christina Bluffs. Radon tests included for four homes, and surface and subsurface soil samples taken from one location. Results summarized from FDOH report.
52-1 6719 Trail Ridge Dr. Lakeland, FL (FDOH results)	5/27/98 (FDOH letter)	16	17.1	18.2	Y	Results are from one surface (0-6-in.) and one subsurface (6-10-in.) sample taken on 5/19/98 at this address by FDOH. These samples were split with Stan Waligora and Andrew Gross (consultants) for independent analyses.
52-1 6719 Trail Ridge Dr. Lakeland, FL (Consultant results)	7/02/98 (Lab report)	11.5	13.9	16.2	Y	This data is taken from a one-page fax of a laboratory report that was addressed to Stan Waligora, and appears to be the results of analyses of samples taken on 5/19/98 and split with FDOH. There are two individual results with a sample date of 5/19/98, but no explanatory report or text is in the file. This lab sheet includes a third result (Ra-226 = 50.8 pCi/g) for a sample taken on 4/9/98, but there is no indication of the location for this sample.

[a] Qualitative indicator of need for additional follow-up action (characterization or remediation) using yes (Y) or no (N) qualifiers based on historical gamma survey data showing indoor or outdoor measurements greater than or equal to 20 μR/hr; Ra-226 soil concentration greater than or equal to 5 pCi/g; indoor radon (Rn-222) greater than or equal to 4 pCi/L; or radon progeny greater than or equal to 0.02 WL. Ra-226 and Rn-222 concentration data are shown in Tables 2 and 3, respectively. In some cases, a Y was assigned when the maximum reported gamma exposure rate was less than 20 μR/hr. This typically was the case if minimal data was available (e.g., no maximum exposure rate reported) and the average exposure rate was on the order of two times background or more. min. = minimum measurement; ave. = average measurement; max. = maximum measurement.

ATTACHMENT 1


ATTACHMENT 1
Further Action Indicated ("Y" –See Notes)
No Further Action ("N" –See Notes)
Airport Runway
Urban Area
Planned Aerial Survey Area
CERCLIS Area
0 1 2 3 4 mi
0 1 2 3 4 5 6 km
Scale 1:65,000
UTM Projection, NAD 1983
Prepared by the Environmental Assessment Division, Argonne National Laboratory
Base data from the U.S. Census Bureau, the U.S. Bureau of Transportation Statistics, and Polk County Government
NOTES
1. This map supplements Table 1. Summary of Historical Florida Department of Health Radiological Survey Results for Selected Subdivisions and Property Developments –External Gamma Exposure Rate Data, from the DRAFT Summary of Historical Florida Department of Health Radiological Survey Data for Polk County, June 2004.
2. Numeric labeling of individual locations (yellow and green triangles) corresponds to the "Subdivision/Development" numbers shown in Table 1 (See Note 1). All locations where further action is indicated have been labeled. To avoid clutter, some locations where no further action is indicated have not been labeled.
3. Qualitative indicator of need for additional follow-up action (characterization or remediation) using yes ("Y") or no ("N") qualifiers based on historical gamma survey data showing indoor or outdoor measurements that exceed 20 μR/hr; Ra-226 soil concentration greater than 5 pCi/g; indoor radon (Rn-222) greater than 4 pCi/L or radon progeny greater than 0.02 WL. Ra-226 and Rn concentration data are shown in Table 2 and Table 3, respectively. In some cases a Y was assigned when the maximum reported exposure rate was less than 20 μR/hr. This typically was the case if minimal data was available (e.g., no maximum exposure rate reported), and the average exposure rate was on the order of two times background or more.
Pasco Co
Hillsborough Co
Polk Co
Polk City
Lakeland
Plant City
Winter Haven
Brandon
Bartow
Lithia
Lake Parker
Lake Hancock
Lake Hollingsworth
Scott Lake
Banana Lake
Lake Thonotosassas
Pleasant Grove Reservoir
Lake Howard
Lake Eloise
Lake Garfield
28°10'0"N
28°0'0"N
27°50'0"N
82°10'0"W
82°0'0"W
81°50'0"W
81°40'0"W
FAS009

ATTACHMENT 2

See Doc ID 10830072